Magnetic Stacks – Differentiating Technology for Advanced Sensors

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Infineon at a glance

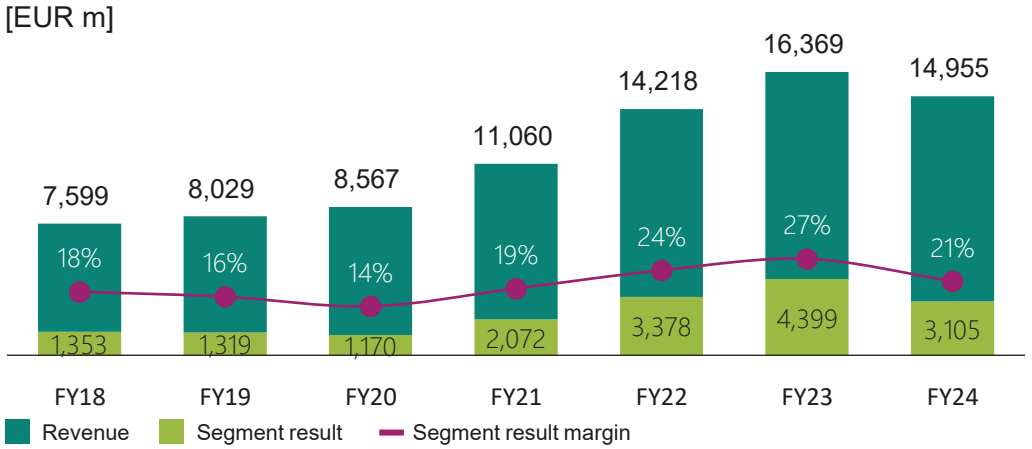
Addressing long-term high-growth trends

Energy
green and efficient

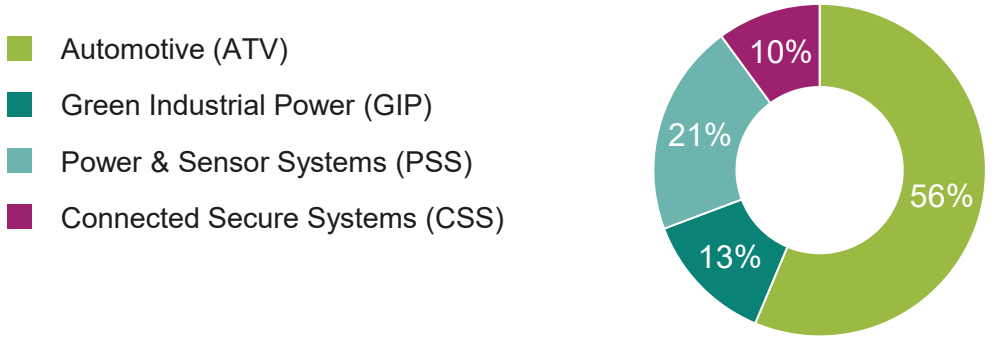
Mobility
clean and safe

IoT
smart and secure

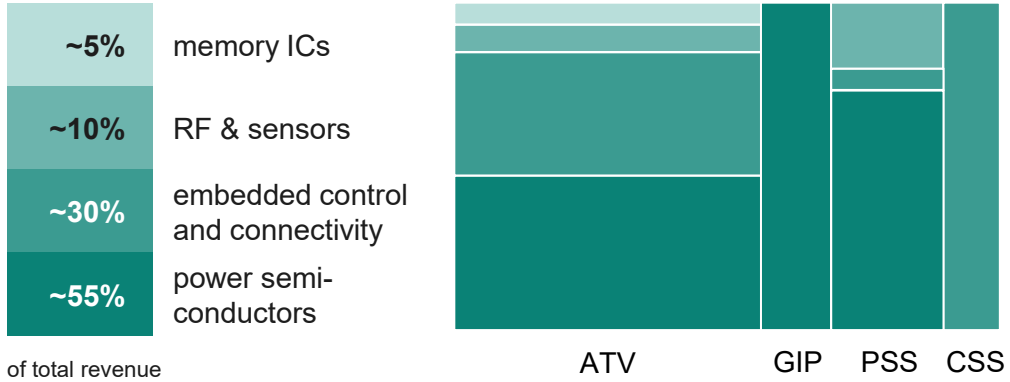
Financials



FY24 revenue by segment

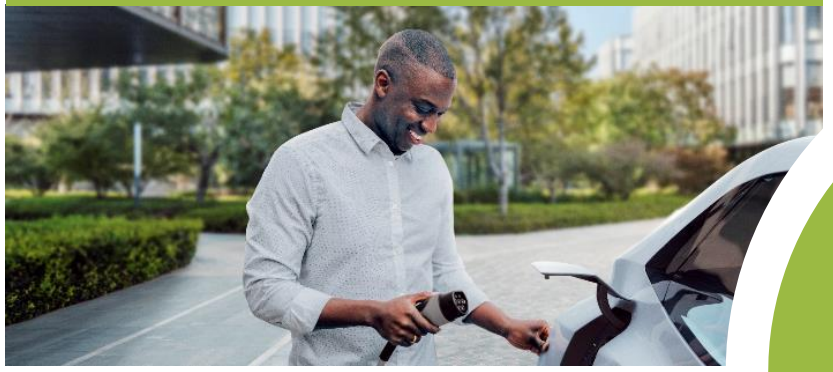


FY24 revenue by product category

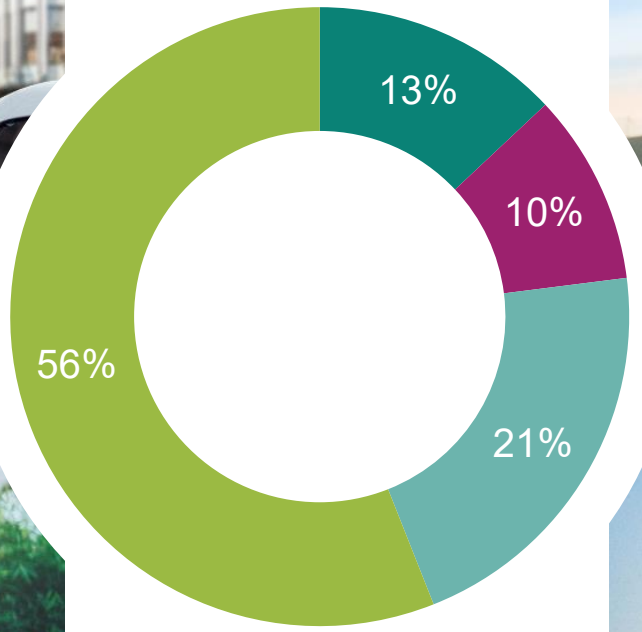


Revenue split by segment

Automotive



Power & Sensor Systems



Green Industrial Power

Connected Secure Systems

Our global Research and Development activities

About 12 percent

of Infineon's annual revenue goes into Research and Development (R&D). In fiscal year 2023, R&D investments amounted to about 2 billion euros.

29,700 patents and patent applications in the overall portfolio

show a high level of innovative strength and longterm competitiveness. In fiscal year 2023 alone, Infineon registered about 1,850 new patent applications.

Numerous innovative ecosystems

with tech companies, universities and research institutes are of great importance to Infineon.

69[1] sites in 25 countries and regions:

Americas	Guadalajara, Tijuana (Mexico); Andover, Austin, Chandler, Colorado Springs, El Segundo, Irvine, Leominster, Lexington, Lynnwood, Morrisville, Murrieta, Portland, San Diego, San José and Warwick (all USA)
Asia Pacific	Bangalore (India); Batam (Indonesia); Cheonan and Seoul (both Korea); Ipoh, Kulim, Melaka and Penang (all Malaysia); Muntinlupa (Philippines); Singapore (Singapore); Nonthaburi (Thailand)
Greater China	Chengdu, Shanghai, Shenzen, Wuxi and Xi'an (all Mainland China); Hsinchu and Taipei (both Taiwan)
Japan	Nagoya, Sendai, Tokyo (all Japan)
Europe	Graz, Klagenfurt, Linz and Villach (all Austria); Herlev (Denmark); Le Puy-Sainte-Réparade (France); Augsburg, Dresden, Duisburg, Erlangen, Ilmenau, Langen, Neubiberg, Regensburg, Soest and Warstein (all Germany); Budapest and Cegléd (both Hungary); Cork and Dublin (both Ireland); Netanya (Israel); Padua and Pavia (both Italy); Nijmengen (Netherlands); Brasov, Bucharest and Iasi (all Romania); Belgrad (Serbia); Bristol and Redhill (both UK); Lviv (Ukraine)

[1] as of 30 September 2023.

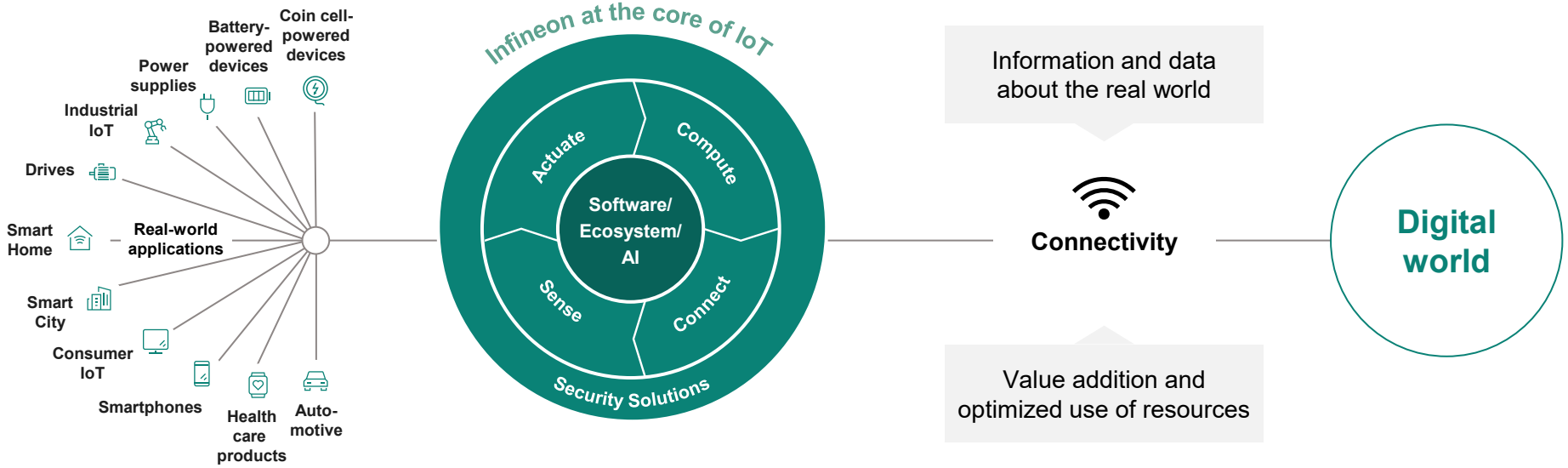
Infineon at the core of IoT – driving digitalization by serving strongly growing multi-application markets

Consumer IoT

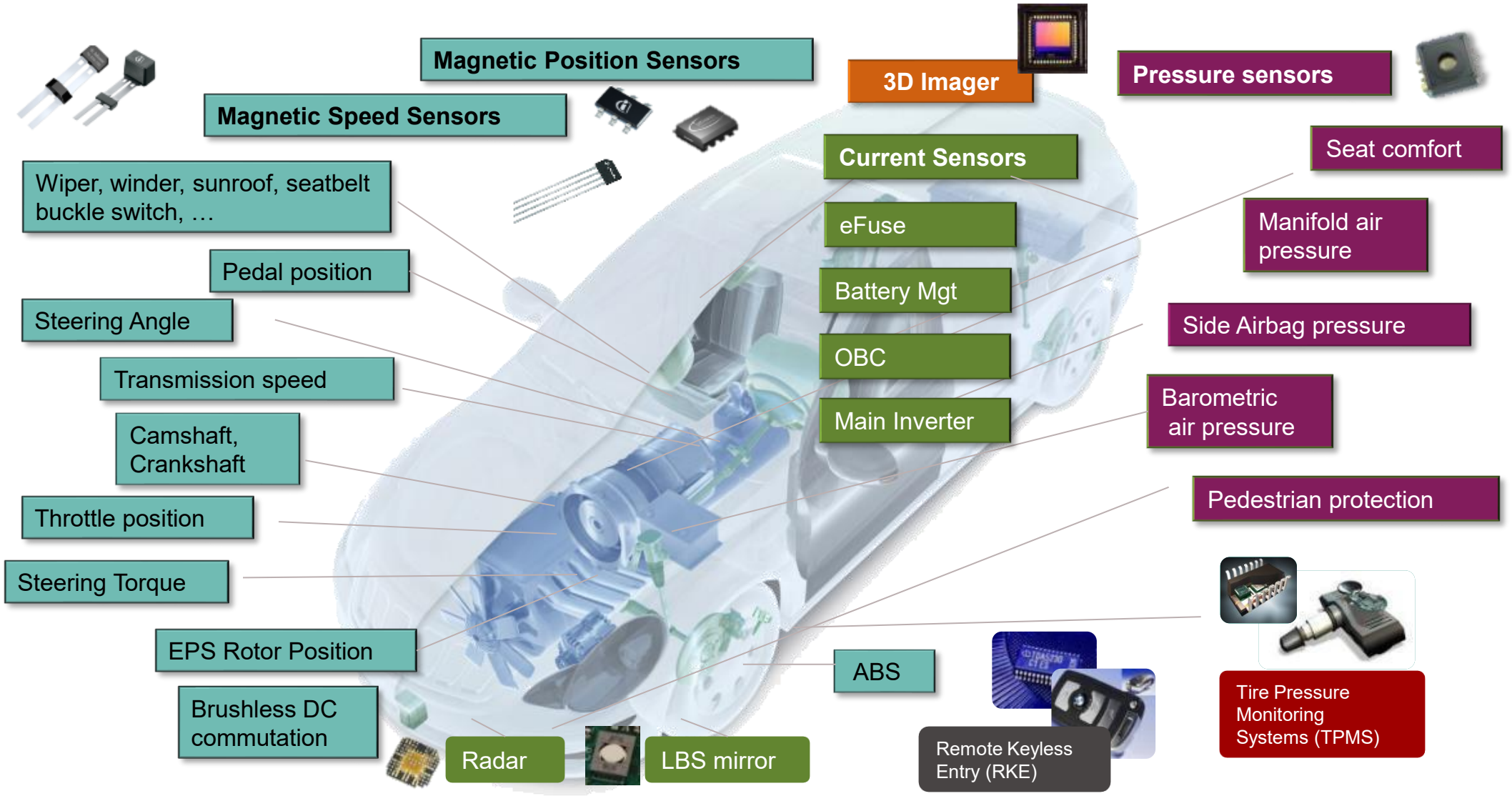
Industrial IoT

Automotive IoT

Products: MCU – Connectivity (Wi-Fi, BLE, NFC) – Sensors – Security – Power supply & switches

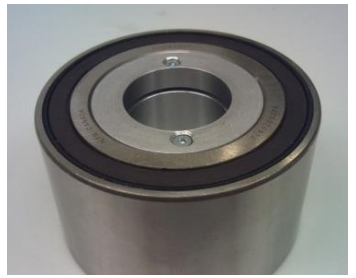


Infineon Sense & Control provides the broadest sensor portfolio for automotive



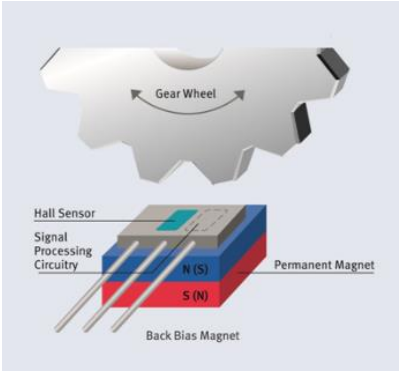
Magnetic sensors are ideal for precise speed sensing in harsh environments.

- Typical automotive speed sensor applications:
  - Wheel speed for ABS, ASR, ESP..
  - Engine speed (crank shaft speed and cam shaft position sensing) for engine ignition control
  - Gear speed sensing in automatic transmission systems
- Two common measurement approaches exist:
  A rotating gear or pole wheel is used as ferromagnetic structure.



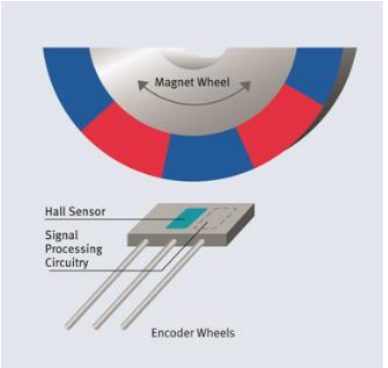
Gear wheel and sensor with back bias magnet:

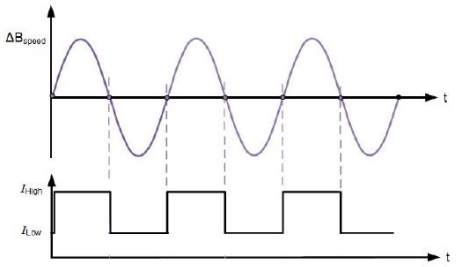
Often preferred solution due to lower system cost



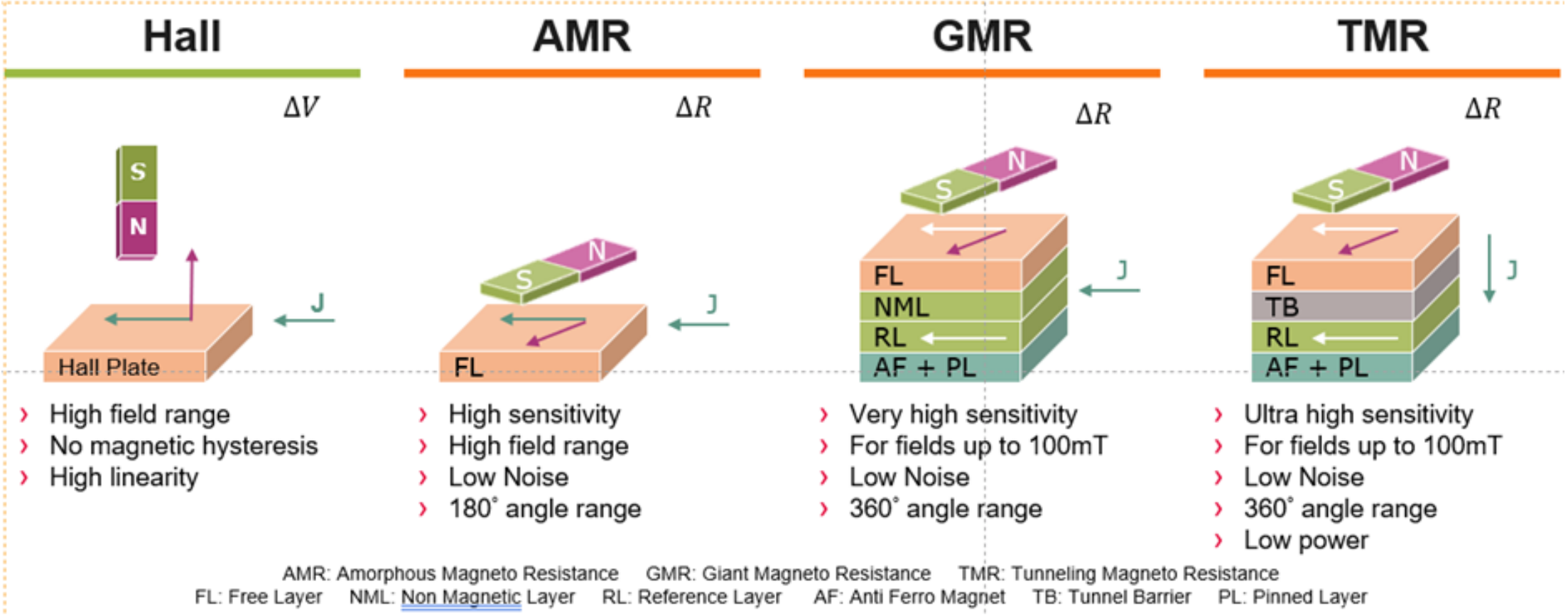
Pole wheel and sensor:

Used in specific applications





Infineon offers the broadest range of magnetic sensing principles in the semiconductor sensor market



- High field range
- No magnetic hysteresis
- High linearity

- High sensitivity
- High field range
- Low Noise
- 180˚ angle range

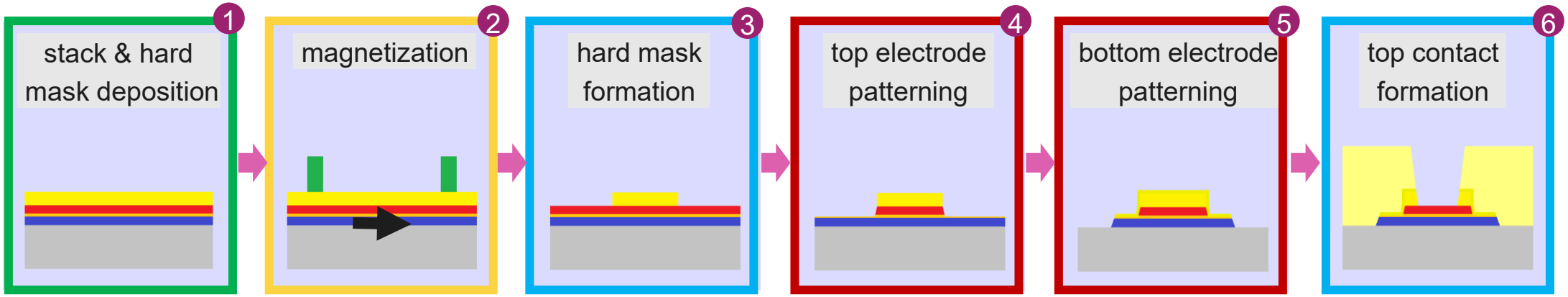
- Very high sensitivity
- For fields up to 100mT
- Low Noise
- 360˚ angle range

- Ultra high sensitivity
- For fields up to 100mT
- Low Noise
- 360˚ angle range
- Low power

AMR: Amorphous Magneto Resistance GMR: Giant Magneto Resistance TMR: Tunneling Magneto Resistance
FL: Free Layer NML: Non Magnetic Layer RL: Reference Layer AF: Anti Ferro Magnet TB: Tunnel Barrier PL: Pinned Layer

→ Sensing technologies are available as discrete solution as well as monolithically integrated on CMOS/BiCMOS

Key Manufacturing Tools for TMR Sensor Formation established in Infineon's Wafer Fab in Regensburg



Deposition PVD

PVD deposition of (magnetic) metals, compounds and insulators/dielectrics

Excellent uniformity

1

Oven Laser Magnetizer

Oven and/or laser with magnetic field option

2

Plasma Etch

Etch tool

hard mask open & top contact

3 6

Ion Beam Etch

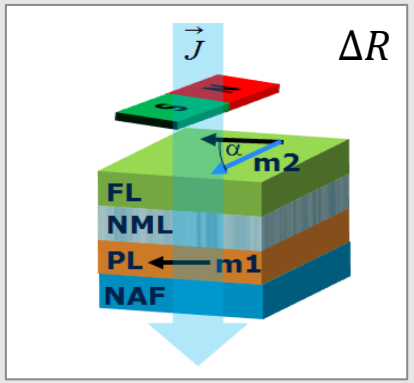
Ion milling

In-situ encapsulation with SiN after etch

4 5

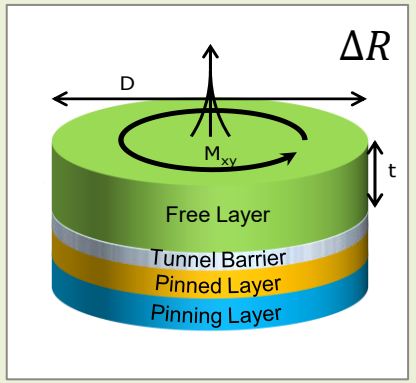
Infineon's Cutting-Edge XENSIV™ Vortex TMR Technology Gives Us the Edge Over Competitor TMR Sensors

Common TMR Sensors



TMR Measurement principle: modifying magnetization direction of a magnetically soft layer.

XENSIV™ Vortex TMR Sensors



Vortex measurement principle: „closed-flux" magnetization aligns in external fields.

Technically Superior TMR-Technology with:
- Better linearity: <0.5% linearity error
- Better cross-field robustness: up to 10^6
- Better output stability: Hysteresis-effects and discontinuities fundamentally excluded

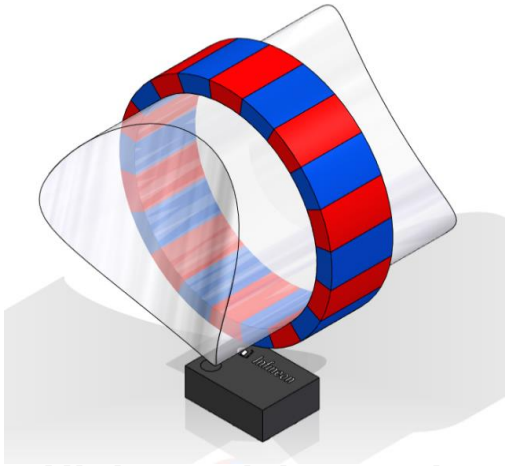
Customized Designs
Vortex TMR enables tailoring of key parameter.

Secure In-House Front-End Production
8" Fab in Regensburg / Germany produces Vortex TMR technology since 2021.

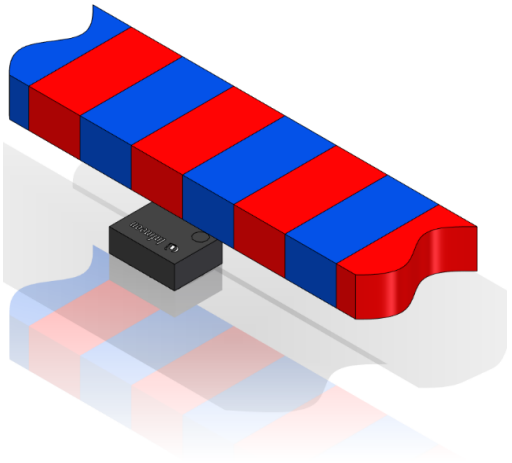
Simulation Support & Demo Boards
Comprehensive support for design-in available.

Infineon's XENSIV™ **Vortex TMR Technology** provides fundamental intrinsic **advantages over competitor TMR sensors** in key parameters relevant for handheld application.

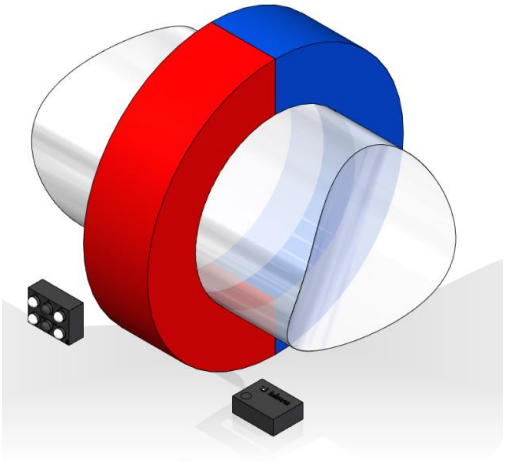
Linear and Rotary Motion Sensing with XENSIV™ Linear TMR Sensors



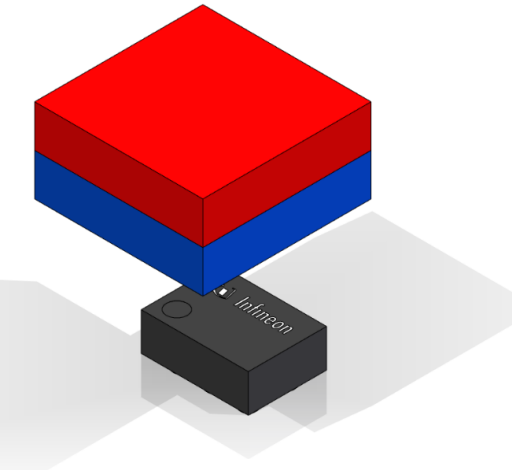
High precision angle
in robotics



High precision linear pos.
mobile cameras



Absolute angle
motion control in gimbals



Absolute linear motion
gaming/HMI applications

Key Take Away Points

- Sensors are the bridge between the „real“ physical world and the digital world
- Magnetic sensors provide position and current sensing in a wide application space, as IoT, Automotive, Robotics, Consumer, Medical, ...
- The skilled combination of highly specialized wafer technology, circuit design, and package allows to taylor the sensor properties to the specific application requirements
- TMR sensors offer superior performance ... and open up new application spaces
- Infineon offers a broad magnetic sensor portfolio, with technology „made in Bavaria“


infineon